

Pain Response to Suctioning in Neonates on Nasal Continuous Positive Airway Pressure

An Honors Thesis Presented in Partial Fulfillment of the Requirements for the Degree of
Bachelor of Science in Nursing With Distinction

The Ohio State University College of Nursing

By

Erin Margaret Bainbridge

Mentors: Esther Chipps PhD, RN, Michele Sweet MS, RN, CNS-Neo and Jacalyn Buck PhD,
RN, NE-BC

.....

The Ohio State University

2015

Abstract

Neonates in respiratory distress are commonly placed on Bubble Nasal Continuous Airway Pressure (NCPAP). To maintain a patent airway and ensure proper functioning of NCPAP, neonates on NCPAP must be suctioned. Suctioning can be one of the most painful procedures done in NICUs. Nurses' conclusions regarding timing and methods of suctioning vary. To date, there is no evidenced based practice for suctioning procedures for neonates. Lack of evidence based practice regarding frequency and method for suctioning NCPAP neonates has led to variable suctioning techniques across NICUs (Mann, Sweet, Buck, & Chipps, 2013). The purpose of this study is to examine NCPAP neonate's pain responses to suctioning. A convenience sample of 15 neonates who meet the inclusion criteria are being recruited from the NICU at Ohio State University Wexner Medical Center. Neonates will be videotaped before, during, and after suctioning. An RN observer will be present for each suctioning to monitor heart rate, oxygen saturation, respiratory rate, and Premature Infant Pain Profile (PIPPs). The neonates PIPP score will be evaluated prior to suctioning and after the suctioning care. Descriptive analysis will be used to determine the neonate's PIPP score variability and to categorize these changes by gestational age. We hope that this study will provide a basis for future studies to find solutions to the neonates pain experience during suctioning.

Chapter I

Introduction

Neonates in respiratory distress are commonly placed on Bubble Nasal Continuous Airway Pressure (NCPAP). To maintain a patent airway and ensure proper functioning of NCPAP, neonates on NCPAP must be suctioned. Nasopharyngeal suctioning can be one of the most painful procedures done in NICUs secondary only to manipulation of NCPAP prongs. Risks associated with suctioning include bradycardia, hypoxemia, increased intracranial pressure, infection, bronchopulmonary dysplasia (BPD), and tracheal trauma. Longitudinal and comparative studies have shown a correlation between inadequate management of neonatal pain and poorer prognosis, alterations in pain pathways, and neurological developmental. The increased understanding of neonatal pain and the effects of unrelieved pain have led to efforts to improve pain control in NICUs. Several evidence-based scales have been developed to better assess infant pain. The Premature Infant Pain Profile (PIPP) is the gold standard. The PIPP scale takes into account the infant's gestational age, heart rate, oxygen saturation, and behavioral state.

To minimize pain and stress, the frequency of suctioning and technique used needs to be examined. Nurses' conclusions regarding timing and methods of suctioning vary. To date, there is limited evidenced-based practice for neonatal suctioning procedures. Lack of evidence-based practice regarding frequency and method for suctioning NCPAP neonates has led to variable suctioning techniques across NICUs. Practice variation is often associated with less favorable outcomes (Mann, Sweet, Buck, & Chipps, 2013).

Developing an evidence based guideline for standardization of safe NCPAP suctioning practice is a vital step in reducing complications associated with NCPAP. The aims of this study are as follows:

Research Aims:

- **Aim 1:** To describe the clinical behavioral responses of neonates on Bubble (NCPAP) in a Level III NICU following routine NCPAP suctioning.
- **Aim 2:** To characterize variability in suctioning response among neonates by gestational age and PIPP score.

Chapter II

Literature Review

Endotracheal Suctioning

Seventy-nine percent of the procedures performed in Neonatal Intensive Care Units (NICU) are considered painful or stressful (Cardoso et al., 2015). As endotracheal suctioning (ETS) is one of the most common painful procedures in the NICU, research has been focused on ways to minimize the neonate's response to pain during suctioning. A descriptive study on adult ICU patients demonstrated that 30% of patients who underwent ETS recalled severe pain with the procedure. It was determined that the percentage was not higher due to the fact that 45% of the patients who underwent ETS were unconscious (Arroyo-Novoa et al., 2007). In comparing painful stimuli in adults and in neonates it was determined that what is painful for adults is painful for neonates as well, even if the neonate does not show the physiological and behavioral symptoms (Byrd, et al., 2009). Moreover, evidence suggests that the continued experience of pain during the first years of life has the potential to alter proper physiological development (Conn, et al., 2013).

In 2004, it was demonstrated that 63.6% of procedures done in the NICU were suctioning related procedures (Ward-Larson, 2004). ETS is performed to reduce secretions in the upper airway and to avoid aspiration related complication. The occurrence of ETS depends on the quantity of secretions, thus varying per patient. It is based on the nurse's assessment as to when the patient needs to be suctioned. Not only will excessive suctioning of a patient lead to more pain for the patient, but could also lead to other complications such as irreversible damage to the tracheal walls (Ward-Larson, 2004). NICU RN observations tells us that not suctioning the infants on NCPAP enough may lead to the infant losing the airway by means of hard thick

secretions in their nose or back of their throat. The clinical judgment of nurses has been shown to vary in a variety of ways, thus when a nurse decides to suction a neonate, he or she must use their clinical judgments.

Reduction of Pain in the NICU

Efforts to reduce pain during elective or stressful procedures encompass both pharmacological and non-pharmacological mechanisms to minimize pain and stress. In 2008, The Society of Neonatology published guidelines for analgesia for specific neonatal procedures. Adapted from the World Health Organization analgesia ladder, these guidelines consist of six steps ranging from non-pharmacological measures (Step 1) to deep sedation using Fentanyl (Step 6). Each common NICU procedure deemed “painful or stressful” has suggested Steps to take for the procedure. For example, for arterial puncture The Society of Neonatology recommends Step 1, 2 and considering 5.

Evidence has demonstrated that these guidelines have had an impact in neonatal pain scores during suctioning. For example, in a randomized, double-blind, placebo control study nurse researchers asserted that dextrose oral solution during nasal oral suctioning decreased PIPP score compared to placebo. The study, however, fails to demonstrate a statistically significant drop in PIPP score as compared to the placebo (Ravishankar,2014). The authors suggested that since the interquartile ranges of PIPP scores were rather high, this could be the reason that no statistically significant change was noted (Ravishankar, 2014).

Another non-pharmacological method to reduce pain in stress in the neonate has been using Four-Handed suctioning. Four-handed care involves two individuals (typically two RNs). One RN is needed to suction the neonate. The other RN helps the neonate to achieve a calm,

relaxed state before, during, and after suctioning. These therapeutic interventions include therapeutic touch and positioning (Cone, 2013). This small pilot study demonstrated no significant differences in heart rate and oxygen saturation during routine care conditions across time periods or for the four handed care (Cone, 2013). However, this study did suggest that even though the sample size was small, the neonates exhibited stressful and defensive behaviors post suctioning as compared to the four handed care (Cone, 2013).

Neonatal Responses to Pain

Historically, neonatal discomfort, stress, and pain have been ignored due to the popular misconceptions that neonate's ascending pain pathways are unmyelinated, meaning they are unable to transmit a pain stimulus to the brain. Another common misconception is that neonates do not experience pain since their thalamocortical connections are not fully developed. These claims are true misconceptions as not one of them is supported by current evidence (Anand, et al. 2000). Quite to the contrary, research has accumulated demonstrating neonates experience the three types of pain: autonomic pain, hormonal pain, and behavioral pain. These three types of pain provide the framework for neonatal pain scales discussed in a later section.

Evidence demonstrates now that neonatal pain and stress are associated with a variety of medical interventions, from a physical examinations to invasive procedures. For the purposes of this study, we will be defining pain as "An unpleasant somatic or visceral sensation associated with actual or potential tissue damage" (Maxwell, Malavolta, Fraga 2013). Stress will be defined as "A disturbance of the dynamic equilibrium between an infant and his/her environment that results in a physiological response by the infant" (Maxwell, Malavolta, Fraga 2013). Several studies have demonstrated that the average NICU patient undergoes 12-18 painful procedures

within the first 14 days of life (Asadi-Noghabi, Tavassoli-Farah, Yousefi, Sadeghi, 2014). Other studies have shown infants admitted to the NICU 25-42 weeks gestation experience on average of 14 painful procedures a day for the first 14 days of life (Simons, van Dijk, Anand, Roofthoof, van Lingen, & Tibboel, 2003).

Longitudinal and comparative studies have shown a correlation between inadequate management neonatal pain and subsequent ability of the neonate to learn new information (Asadi-Noghabi, Tavassoli-Farah, Yousefi, Sadeghi, 2014). Similarly, studies on laboratory animals have illustrated repeated tissue damage alters pain and somatosensory pathways. This results in increased nociceptors responses to subsequent injury later in life (Brummelte, Grunau, Chau, Poskitt, Brant, Vinal, et al, 2009) Several longitudinal studies have indicated the infants exposed to gastric suctioning at birth evidenced three fold greater odds of developing IBS later in life (Ren, Wu, Yew, Ziea, Lao, Leung, et al, 2007). One comparative study done in the 2013 demonstrated that prolonged stress due to pain is directly related to the permanent decrease of hippocampal dendrites (Zhao, Ou, Cheng, Xia, He, Zhang, et al 2013).

The increased understanding of neonatal pain and the effects of unrelieved neonatal pain have lead to efforts to improve pain control in NICUs. The American Academy of Pediatrics established guidelines for neonatal pain prevention and treatment which includes: routine assessment for the detection of pain, reduction of the number of painful procedures, and guidelines and protocol to prevent/reduce pain from invasive procedures at the bedside (American Academy of Pediatrics 2010). Yet, accurate pain assessments in the neonate remain difficult due to the inability to self-report pain experience.

Several evidence-based scales have been developed to better assess infant pain. The Premature Infant Profile has continuously demonstrated more precision and accuracy than other

pain scales. The Premature Infant Pain Profile (PIPP) is a composite measure that includes three behavioral (brow bulge, eye squeeze, and nasolabial furrow), two physiological (heart rate and oxygen saturation) and two contextual (gestational age and behavioral state) indicators (Ballaynte, Stevens, McAllister, Dionne, & Jack, 1999). Scores are ranged from 0-21 with a score of 12 being an indicator of pain (Ballaynte, Stevens, McAllister, Dionne, & Jack, 1999). In a cross over study, the PIPP score demonstrated internal validity and feasibility. In a quasi analysis study, the PIPP score demonstrated excellent interrater reliability (0.93-0.96) and intrarater reliability (0.94-0.98) (Ballaynte, Stevens, McAllister, Dionne, & Jack, 1999).

The PIPP scale has provided a consistent tool to quantify patient's pain experience. However, health care providers including nurses, still demonstrate a lack of knowledge and understanding as to what is painful to the neonate. Across the board most studies have shown that nurses understand that neonates do experience pain. Yet, there is a lack of understanding as to how to control neonatal pain, what is painful to the neonate, etc.

In a descriptive and analytical study from 2013, nurse researches determined that a low level of nurses provided pharmacological and non-pharmacological pain control methods for painful procedures such as IM injections, blood sampling, and venipuncture (Dodd, 2013). Nurses in the study showed knowledge deficits over pain management in neonates. "They [nurses] also knew little about pharmacology in particular when it was required to administer analgesia, ordered 'as needed' to maintain steady state of analgesia (Dodd, 2013). These findings suggest that neonatal floor nurses need more education as to pain in the neonate and interventions.

Another study provided education to the neonatal nurses specific to neonatal pain during ETS. The study showed that before the education intervention, pain scores among nurses varied

before, during and after ETS. After the education, the pain scores demonstrated that nurses recognized neonates as experience pain heavily during and after ETS. Thus, demonstrating that education had effect on reducing pain severity during and after ETS. Nurses were able to better recognize the pain and provide appropriate interventions (Hadian & Sabet, 2013). The same study demonstrated that nurses who demonstrated a high level of knowledge regarding pain demonstrated more positive attitude toward pain management (Hadian & Sabet, 2013).

Today, the incidence of NICU patients needed suctioning on NCPAP (bubble) is becoming more and more common. The aims of this study are to describe the pain responses neonates on bubble (NCPAP) in a level III NICU following routine NCPAP suctioning. Also, to describe neonatal nurses perception of pain experienced by neonates during suctioning. Ultimately, the goal is to establish baseline assessments to hopefully lead to better-increased incidence of neonatal pain across the board.

Chapter III

Methods

Design

A descriptive pilot study that gathered observational and behavioral data during routine care of neonates on Bubble NCPAP (Aim 1). Physiological variables including heart rate (HR), respiratory rate (RR), and oxygen saturation are measured before, during, and after suctioning. For Aim 2, within-subjects repeated measures design was used neonates served as their own controls. Data will be analyzed to characterize variability in suctioning responses among neonates on Bubble NCPAP. For Aim 4, neonatal RNs will be invited to participate in a thirty to forty-five minute focus group that will gather data on their perceptions of management of neonatal pain.

Setting

This project took place at The Ohio State University Wexner Medical Center (OSUWMC) Neonatal Intensive Care Unit (NICU), 6 Doan.

Sample

Convenience samples of 15 neonates who meet the inclusion criteria were recruited from OSUWMC NICU, a Level III NICU. Inclusion criteria was as follows: (1) are on Bubble NCPAP, (2) are 27-32 weeks gestation, (3) are older than 3 days of life but less than 7 days of life, (4) have legally authorized representatives, (5) are clinically stable as defined by the NICU healthcare team. The exclusion criteria are as follows: (1) any facial or cranial deformities, (2) chromosomal/genetic abnormalities, (3) congenital heart disease, (4) chest tube placement, (5)

persistent abnormalities hypertension, (6) receipt of any medications that alter responses to pain such as paralytics, narcotics, and other sedatives.

Measures

The heart rate (HR), respiratory rate (RR), oxygen saturation (PaO₂), and Premature Infant Pain Profile (PIPP) will be measured in each neonate prior to the painful event and within 30 seconds of the painful event. Health and demographic data collected will be diagnosis, gestational age, birth age, birth weight, and gender.

Instrument

The Premature Infant Pain Profile (PIPP)

Data Collection Procedures:

Following informed consent from parental guardians, demographic and medical information were collected from the electronic medical record. Two senior NICU RN's and the Clinical Nurse Specialist (CNS) served as the study RNs. This will provide interrater reliability on the suctioning guideline that were used as the basis for routine care. In addition, the use of these two RNs or CNS reduced the variability in neonatal suctioning responses that is attributable to RNs having different suctioning techniques. Assigned RN caregiver for each neonate notified the study RNs during routine care times, to ensure observation occurred during naturally occurring suctioning opportunities.

As a team, the study RNs, study evaluators, and the caregiving RN will determine and record the beginning of each pre-suctioning period. The study RN will start the suctioning procedure. At the start, the study evaluator will document the neonate's heart rate (HR), respiration rate (RR), and oxygen saturation. Whether oral or nasal, each suctioning pass will be perceived as a single event. The study evaluator will record the HR, RR, and oxygen saturation

again when suctioning is completed. The final recording of the HR, RR, and oxygen saturation will occur either 10 minutes post suctioning procedure or when the neonate has returned to within 10% of baseline physiological measures.

The suctioning method used for this study is the agreed upon “best practice” on the routine normal care as determined by the nursing clinical experts of the OSUWMC NICU. The nurse will assess the neonate suction needs and then place the infant on a Z-flo™ positioner to keep the neonate in a flexed position. Before suctioning, blow by oxygen will be increased by 5-10% to increase oxygen concentration. The neonate’s weight will determine the suctioning catheters size. The suction will be set to use the lowest amount of necessary pressure (between 60-100 mm Hg) to eliminate secretions. While pulling out the suctioning catheter for 5-10 seconds, the suction is applied. Lubricant can be used for nasopharyngeal suctioning catheters.

As outlined in the agreed upon protocol, the study RN will carry out the suctioning event. One of the two trained study evaluators will record observations 5 minutes pre-suctioning, during suctioning, immediately after suctioning, and 10 minutes after suctioning or return to 10% of the neonate’s baseline physiological parameters.

Data Analysis:

Descriptive analysis was used to evaluate this interim data collection. The PIPP scores associated with each suctioning event were compared to the patient’s baseline. Using correlational analysis, the relationship between the patient’s PIPP score and gestational age were examined.

Chapter IV

Results

At the time of data collection a total of ten neonates on NCPAP were consented and suctioned during routine care by one of the study RNs. All neonates suctioned experienced rises in PIPPs scores during suctioning and returned to baseline post suctioning or post cares. There were no observed trends between gestational age and the time it took the neonate's PIPPs and vitals to return to baseline. It should be noted that Subject 2 did not complete the study and is not included in this data. Figure 1 illustrates these findings.

Table 1: *Subjects PIPP Scores During Care*

Subject	GA	Baseline	R Nares	L Nares	Mouth	Immediately After Suctioning	Post Suctioning	Post Cares
Subject 1	28 and 5	3	6	9	5/9	3	4	-
Subject 3	27 and 6	6	-	-	3	12	5	-
Subject 4	27 and 6	6	-	-	-	-	-	-
Subject 5	27 and 6	4	-		7/7	9	4	4
Subject 6	28 and 4	3	4	4	3	4	3	3
Subject 7	31 and 0	3	5	5	4	5	5	3
Subject 8	29 and 3	4	9	10/10	5	7	6	4
Subject 9	-	4	10/10	6/6	9	9	5	4
Subject 10	31 and 6	4	7	7	9/9	-	-	-
Subject 11	30 and 3	4	8	8	11/11/11	5	6	-

The data was then examined to look at the trends in PIPPs scores during oral and nasal suctioning. Subjects were divided into two separate data groups based on if the PIPP score remained at baseline during mouth suctioning. Four of the six neonates who required both nasal and mouth suctioning demonstrated their baseline PIPP scores during mouth suctioning and a rise in PIPP scores during nasal suctioning. The other two subjects PIPPs score rose during mouth suctioning and dropped within two points of baseline during nasal suctioning. These two neonates were found to be of an older gestational; 30 weeks and three days and 31 weeks and 6 days respectively. Both Subject 4 and Subject 9 were not included in this data as Subject 4 has was missing PIPP scores and Subject 9's gestational age data is missing. Figure 1 shows the PIPP scores for the subject's whose PIPP scores remained at baseline during oral suctioning. Figure 2 shows the PIPP scores for the subject's whose PIPP scores increased above nasal suctioning PIPP scores during oral suctioning.

Figure 1: *PIPP score for Subject 1 and Subjects 6-8*

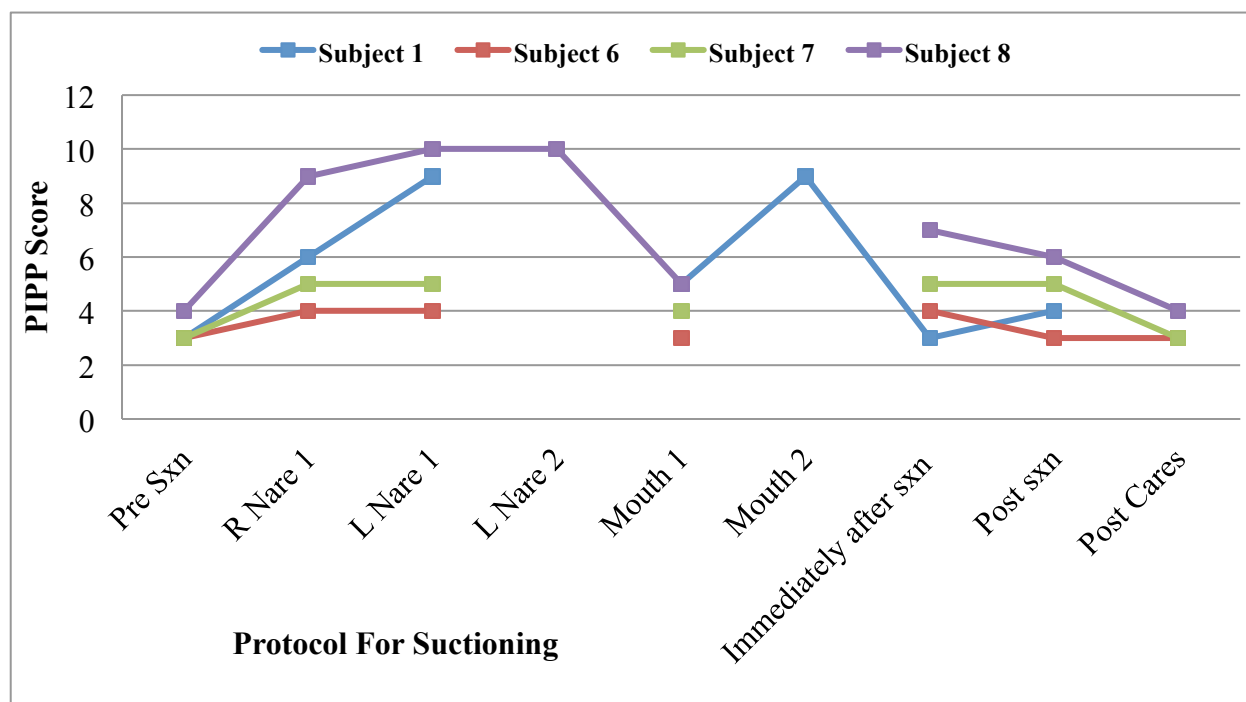
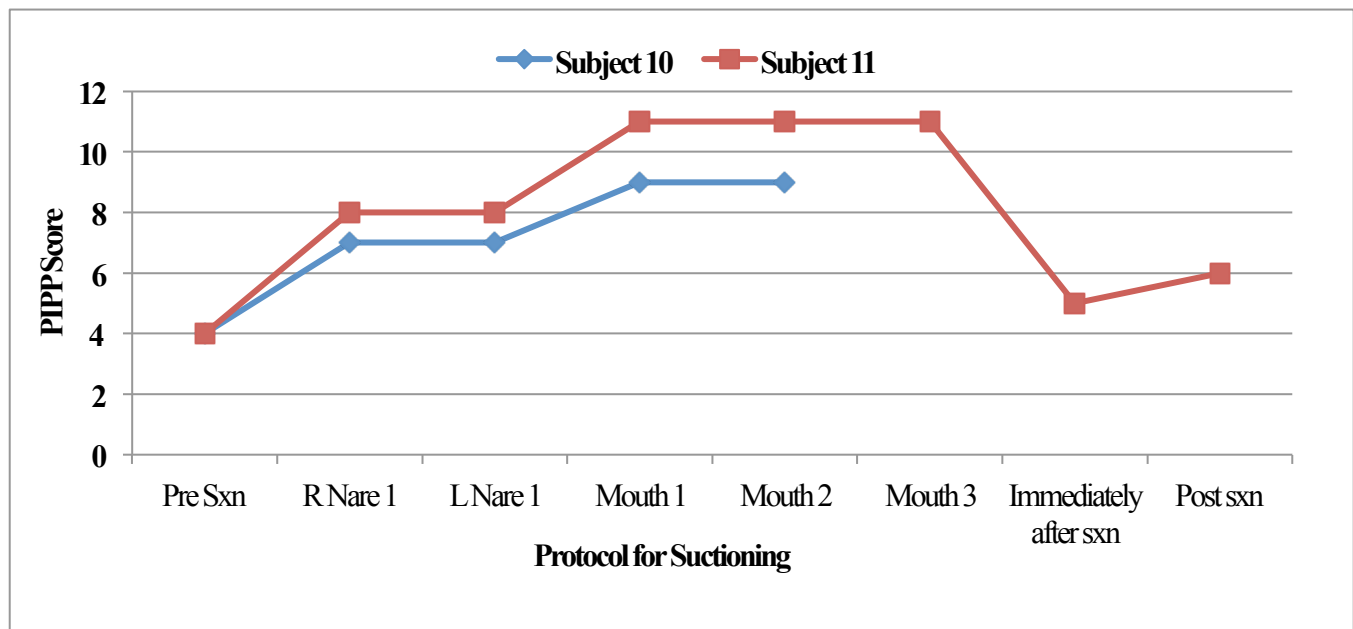


Figure 2: PIPP scores for Subjects 10-11

As previous studies have indicated, the data demonstrated that the more suctioning passes the neonate required the higher the subjects PIPP score went. Suctioning passes refers to how many times the RN advances the catheter in the nasal and/or oral cavity to remove secretions. The data suggests that the more suctioning passes the neonate required, the higher the PIPP scores became and the longer it took the infant to return to baseline vitals and PIPP scores.

As described in the literature, the NCPAP prongs being placed back in the neonate's nares is very painful for the neonate. Six out of seven neonates demonstrated an increase in PIPP score from the last suctioning pass to immediately after suctioning when the prongs were placed back into the nares.

Chapter V

Discussion and Conclusion

The goal of this project was to help describe the clinical/behavior responses to neonates on NCPAP, to characterize variability in suctioning response among neonates by gestational age, and to generate data that will lead to subsequent larger studies. These interim results described in Chapter IV suggest that the degree of pain NCPAP neonates experience during suctioning varies considerably by gestational age, number of suctioning passes, and by what orifice(s) were suctioned

All neonates experienced some degree of rise in PIPP score during suctioning and a return to baseline PIPP scores post suctioning or post cares. These findings support the large body of evidence that neonates do experience pain during suctioning and their pain experience terminates post suctioning or post cares. Figure 1 supports these findings.

As shown in Figures 2 and 3, neonates experienced a rise in PIPP score immediately after suctioning when the prongs were being secured into the nares. These findings supports the (Cignacco, 2013) that concluded manipulation of the prongs is the most painful procedural pain experienced by the NCPAP neonate followed by ETT suctioning. Future studies should examine ways to reduce the pain associated with manipulation of the NCPAP prongs and reduction of pain experienced during ETT suctioning.

Neonates who experienced both oral and nasal suctioning throughout the entire suctioning sequence experienced more of a pain response with nasal suctioning than oral suctioning. It can be inferred from this data that neonates experience a rise in PIPP score during nasal suctioning due to the conditions simulating the manipulation of the NCPAP prongs.

The limitations of the study were that it is a pilot study seeking to gain information for a larger study. Next, the study examined only one NICU's suctioning procedure protocol. The sample size was small and therefore only trends were evaluated

In conclusion, this data suggests that neonatal pain response to suctioning on NCPAP is highly variable. Future studies should seek to standardize practice for suctioning neonates on NCPAP and mechanical ventilation (MV), examine both pharmacological and non-pharmacological pain management techniques, and understanding nurses' perception of the neonatal pain experience. Evidence-based suctioning techniques will lead to better clinical outcomes for neonates on bubble NCPAP.

References

- Ackley, B.J., Ladwig, G.B., & Rogers, P.A.(2006). Nursing diagnosis handbook: A guide to planning care. (7th ed.). St. Louis: Mosby Elsevier.
- Anand, K.J. (2000). Pain, Plasticity, and premature birth: a prescription for permanent suffering?. *Nat Med*, 6(9), 971-973.
- Arroyo-Novoa C, Figueroa-Ramos M, Wild L, et al. Pain related to tracheal suctioning in awake acutely and critically ill adults: a descriptive study. *Intensive & Critical Care Nursing: The Official Journal Of The British Association Of Critical Care Nurses* [serial online]. February 2008;24(1):20-27. Available from: MEDLINE with Full Text, Ipswich, MA. Accessed April 15, 2015.
- Asadi-Noghabi, F., Tavassoli-Farahi, M., Yousefi, H., & Sadeghi, T. (2014). Neonate pain management: what do nurses really know?. *Global Journal Of Health Science*, 6(5), 284-293. doi:10.5539/gjhs.v6n5p284
- Ballantyne, M., Stevens, B., McAllister, M. Dione, K., & Jack, A (1999). Validation of the Premature infant pain profile in the clinical setting. *Clinical Journal of Pain*, 15 (4), 297-303.
- Barbosa, A., Cardoso, M., Brasil, T., & Schochi, C. (2011). Endotracheal and upper airways; changes in newborns' physiological parameters. *Rev. Latino-American Enfermagem*, 19(6), 1169-76.
- Batton, D. G., Barrington, K. J., & Wallman, C. (2006). Prevention and management of pain in the neonate: an update. *Pediatrics*, 118(5), 2231-2241
- Bonner, K. & Mainous R. (2008). The nursing care of the infant receiving bubble CPAP therapy. *Advances in Neonatal Care*, 8 (2), 78-95.

- Brummelte, S., Grunau, R.E., Chau V, Poskitt KJ, Brant, R., Vinall, J., et al. Procedural pain and brain development in premature newborns. *Ann Neurol* 2012; 71:385-96.
- Byrd P, Gonzales I, Parsons V. Exploring barriers to pain management in newborn intensive care units: a pilot survey of NICU nurses. *Advances In Neonatal Care: Official Journal Of The National Association Of Neonatal Nurses* [serial online]. December 2009;9(6):299-306.
- Cardoso, J, Kusahara, D, Guinsburg, R, Pedreira M. (2014) Randomized crossover trial of endotracheal tube suctioning systems use in newborns. *Nursing In Critical Care*.
- Cignacco, E., Hamers, J. van Linge, R., Stoffel, L., Buchi, S., Muller, R., Schutz, N., Zimmerman, L., & Noelle, M. (2009). Neonatal procedural pain exposure and pain management in ventilated preterm infants during the first 14 days of life. *Swiss Medical Weekly*, 139(15-16), 226-232.
- Cone, S., Pickler, R. H., Grap, M. J., McGrath, J., & Wiley, P. M. (2013). Endotracheal Suctioning in Preterm Infants Using Four-Handed versus Routine Care. *JOGNN: Journal Of Obstetric, Gynecologic & Neonatal Nursing*, 42(1), 92-104. doi:10.1111/1552-6909.12004
- De jonckhere, J.; Rakza, T.; Logier, R.; Jeanne, M.; Jounwaz, R.; Storme, L. (2011). "Heart rate variability analysis for newborn infants prolonged pain assessment," *Engineering in Medicine and Biology Society, EMBC, 2011 Annual International Conference of the IEEE*, vol., no., pp.7747,7750,
- Dodds, E. (2003). Neonatal procedural pain: a survey of nursing staff. *Paediatric Nursing*, 15(5), 18-21.
- Grunau, R. E., Holsti, L., Haley, D. W., Oberlander, T., Weinberg, J., Solimano, A., & ... Yu, W. (2005). Neonatal procedural pain exposure predicts lower cortisol and behavioral reactivity in preterm infants in the NICU. *Pain*, 113(3), 293-300.

- Gnass, I., Ralic, N., Hübner-Möhler, B., & Sirsch, E. (2014). [Expert standard "pain management in nursing of chronic pain". An unpleasant sensory and emotional experience]. *Pflege Zeitschrift*, 67(9), 520-523.
- Grunau, R. E., Holsti, L., Haley, D. W., Oberlander, T., Weinberg, J., Solimano, A., & ... Yu, W. (2005). Neonatal procedural pain exposure predicts lower cortisol and behavioral reactivity in preterm infants in the NICU. *Pain*, 113(3), 293-300.
- Hadian, Z. S., & Sabet, R. S. (2013). The effect of endotracheal tube suctioning education of nurses on decreasing pain in premature neonates. *Iranian Journal Of Pediatrics*, 23(3), 340-344.
- Mann, B., Sweet, M., Knupp, A., Buck, J., & Chipps, E (2013). Nasal continuous positive airway pressure: a multisite study of suctioning practices within NICUs. *Advances in Neonatal Care*, 12,2, E1-E9.
- Maxwell, L. G., Malavolta, C. P., & Fraga, M. V. (2013). Assessment of pain in the neonate. *Clinics In Perinatology*, 40(3), 457-469.
- Padhye, N. S., Williams, A. L., Khattak, A. Z., & Lasky, R. E. (2009). Heart Rate Variability in Response to Pain Stimulus in VLBW Infants Followed Longitudinally During NICU Stay. *Developmental Psychobiology*, 51(8), 638–649. doi:10.1002/dev.20399
- Peng, N., Bachman, J., Jenkins, R., Chen, C., Chang, Y., Chang, Y., & Wang, T. (2009). Relationships between environmental stressors and stress biobehavioral responses of preterm infants in NICU. *Journal Of Perinatal & Neonatal Nursing*, 23(4), 363-371. doi:10.1097/JPN.0b013e3181bdd3fd
- Prevention and management of pain and stress in the neonate. American Academy of Pediatrics. Committee on Fetus and Newborn. Committee on Drugs. Section on Anesthesiology.

Section on Surgery. Canadian Paediatric Society. Fetus and Newborn Committee. (2000).
Pediatrics, 105(2), 454-461.

Ravishankar, A., Thawani, R., Dewan, P., Das, S., Kashyap, A., Batra, P., & Faridi, M. A.
(2014). Oral dextrose for analgesia in neonates during nasogastric tube insertion: a
randomised controlled trial. *Journal Of Paediatrics And Child Health*, 50(2), 141-145.
doi:10.1111/jpc.12392

Ren, T., Wu, J., Yew, D., Ziea, E., Lao, L., Leung, W., & ... Sung, J. Y. (2007). Effects of
neonatal maternal separation on neurochemical and sensory response to colonic distension in
a rat model of irritable bowel syndrome. *American Journal Of Physiology. Gastrointestinal
And Liver Physiology*, 292(3), G849-G856.

Simons, S. H. P., Van Dijk, M., Anand, K.S., Roofhooft, D., van Lingen, R. A., & Tibboel, D.
(2003). Do we still hurt newborn babies?: A prospective study of procedural pain and
analgesia in neonates. *Pediatric Adolescent Medicine*, 157 (11), 1058.

Slevin, M., Daly, L., & Murphy, JE. (1998). Preterm infants stress response to an invasive NICU
event; Endotracheal suctioning. *Journal of Reproductive and Infant Psychology*, 16(4).

Tan, A, Gomez, JM., Mathews, J., Williams, M., Paratz, J., & Rajaduri, VS. (2005). Closed
versus partially ventilated endotracheal suction in extremely preterm neonates:
physiological consequences. *Intensive and Critical Care Nursing*, 21, 234-242.

Ward-Larson C, Horn R, Gosnell F. The efficacy of facilitated tucking for relieving procedural
pain of endotracheal suctioning in very low birthweight infants. (2004)*MCN. The
American Journal Of Maternal Child Nursing*. 29(3):151-15

Zhao, Y. D., Ou, S., Cheng, S. Y., Xiao, Z., He, W. J., Zhang, J. H., & Ruan, H. Z. (2013).

Dendritic development of hippocampal CA1 pyramidal cells in a neonatal hypoxia-ischemia injury model. *Journal Of Neuroscience Research*, 91(9), 1165-1173.

Appendix A

Below is the Proposed OSUWMC Suctioning Practices used for this study.

Proposed OSUWMC Suction Practice Guideline for care of the infant after the first 72 hours of life and within the first week of life

Procedure

1. Assess clinical indications for suctioning from your assessment, any symptoms of respiratory distress, previous tolerance and amount of suctioning required and secretions received as reported or documented in the previous shift, and the fit of the nasal prongs and ncpap set-up.
 - a. Assessment indicators requiring suction include and not limited to: Increased WOB, visible mucus in the prongs, retractions, increasing RR, coarse breath sounds heard over the oral airway, nose and throat.
 - b. Avoid routine suctioning without clinical indicators, and suction infant only with the outlined clinical assessment criteria.
 2. Perform hand hygiene and apply gloves
 3. Choose the following suction catheter sizes, using the largest sized catheter which will pass without resistance. Separate catheters may be used for suctioning oral and nasal airways:
 - a. 6 Fr for infants <1000 grams (for nares)
 - b. 8 Fr for infants >1000 grams
 - c. 8 or 10 Fr for oral secretions as needed
 4. Check suction system.
 - a. Set suction control at 60 to 100 mm Hg. Use the least amount of negative pressure necessary to remove secretions.
 - b. Prepare normal saline for instillation as needed. Squeeze saline from bullet into sterile tray of suction catheter kit or open saline bullet and place in suction catheter kit. If NS is used 3-5 gtts are recommended to loosen thick and hardened secretions.

Note: Thin vs. thick secretions can be managed via the maintenance of the humidification in the corrugated tubing set per Respiratory Therapy. By dialing dry to more wet humidity related to the flow and temperature in the tubing secretions consistency can be managed and the use for saline decreased. The heater is set at 37 C (98.6F)
 5. Ensure that an appropriately sized resuscitation bag and mask are connected to an oxygen source at the bedside.
 6. Complete a pre-suctioning pain score, assessment baseline vital signs (VS) and intervention for pain, such as swaddling or nesting infant
 7. Remove the chin strap if in use and prongs from the nares.
 8. Increase FIO2 by 5-10% for blow-by or cpap, administer as needed to maintain target oxygen saturation levels.
 9. Assess nares and columella for redness, breakdown and visible secretions.
- Suctioning Technique

NOTE: The order in which to suction mouth before nares is at the clinical discretion of the nurse.

10. OROPHARYNGEAL SX- First insert catheter 8 or 10 French (without applying suction) to recommended depth from the mouth to the suprasternal notch in an upward and backward direction.

- a. Apply suction and gently withdraw not taking more than 5-10 seconds.
- b. Repeat as needed to clear the oral secretions.
- c. Monitor the infant tolerance to suction including the HR, saturation level and work of breathing.
- d. Administer oxygen as needed with the FIO₂ by 5-10% above the baseline by blow-by or cpap, to maintain target oxygen saturation levels prior to suctioning the nares.

11. NASOPHARYNGEAL SX- Insert catheter 6 or 8 French (without applying suction) to recommended depth: In infants and young children, 4 to 8 cm (2 to 3 inches) or by measuring from the tip of the nose to the tip of the ear lobe or tip of suprasternal notch for the estimated length required for insertion.

- a. Lubricate the tip of the catheter in some normal saline prior to introducing the catheter into the nares.
- b. Remove the prongs from the nares as tolerated and place them onto a dry wipe at the head of the bed. (It is strongly recommended to not place the nasal prongs directly in the bed.)
- c. Routine use of nasal saline(NS) is not recommended in the nares. If NS is used 3-5 gtts are recommended to loosen thick and hardened secretions.
- d. Introduce the catheter gently into the nostril and ease it to the back of the pharynx .
- e. Suction is applied once the catheter is inserted. Apply suction and gently withdraw the catheter not taking more than 5-10 seconds.

12. Reassess infant's work of breathing, HR, oxygen saturation, and tolerance to suction.

13. Administer oxygen as needed with the FIO₂ by 5-10% above the baseline by blow-by or cpap, to maintain target oxygen saturation levels

14. Only repeat suctioning in the nares if copious secretions remain visible hanging off the catheter , in the infant's nares, or your respiratory assessment determines the need for suctioning. After each pass, allow the neonate time to recover (as indicated by the neonate's oximetry and cardiorespiratory monitor) by providing positive pressure ventilatory support.

15. Note character and amount of secretions removed.

16. Repeat nasopharyngeal suction process in the other nares.

17. Return the prongs to the nares ensuring they fit safely and snugly without blanching of the nares.

18. Using sterile water and wipes provide mouth care by moistening lips and removing any secretions which may have accumulated.

19. Apply chin strap to prevent loss of pressure through the mouth, if applicable.

20. Listen to neonate's breath sounds immediately after application of NCPAP to determine if flow from the device is heard equally throughout lung fields.

21. Reposition neonate to maximize comfort, promote flexion, and improve oxygenation.

22. Inspect entire NCPAP device for leakage at connections and twisting of the tubing that may compromise safe application to the patient.

23. As needed, flush and rinse the catheter with normal saline

24. Remove gloves and perform hand hygiene.

25. Monitor oxygenation levels before, during, and after suctioning, and adjust support to prevent extremes of oxygenation.

26. Monitor cardiac and respiratory stability.
27. Wean oxygen to pre procedure level, as tolerated.
28. Monitor the neonate's tolerance of the procedure with the baseline vs and the PIPP pain scale indicators.
29. Discard supplies, remove glove(s), and perform hand hygiene.
30. Reassess pain score and document the procedure in the neonate's record.
31. Handoff at change of shift to include infant requirements for suctioning during the nurses shift: assessed need for suctioning and frequency, tolerance, amount of secretions received and associated desaturations or bradycardia events associated with an increased frequency for suctioning.